DOCUMENT RESUME

ED 397 732 HE 029 332

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TITLE Implementing Astin's I-E-O Model in the Study of Student Retention: A Multivariate Time Dependent Approach. AIR 1996 Annual Forum Paper.
PUB DATE May 96
NOTE 26p.; Paper presented at the Annual Forum of the Association for Institutional Research (36th, Albuquerque, NM, May 5-8, 1996).
PUB TYPE Reports - Evaluative/Feasibility (142) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Academic Persistence; Case Studies; *Dropout Characteristics; Higher Education; Institutional Research; *Military Schools; Military Training; Models; Organizational Climate; Predictor Variables; Social Integration; *Statistical Analysis; *Student Adjustment; Theories; Time Perspective
IDENTIFIERS *AIR Forum; Coast Guard Academy CT; *Input Environment Output Model

ABSTRACT

A study used Alexander Astin's (1993) Input-Environment-Output (I-E-O) model to examine persistence at the United States Coast Guard Academy (Connecticut). Because the study was conducted in a controlled social environment, measures of social environmental influence were derived from multiple inputs, including adaptability polls wherein every student's "fit" was assessed by all others in his organizational unit each semester. Subjects were 619 cadets entering the Academy with the classes of 1991 and 1993; the groups had similar profiles. The research questions addressed the extent to which (1) input variables and academic and social involvement at the end of each of the first four semesters differentiated between persisters and non-persisters; and (2) how input variables related to academic and social integration. Results confirmed the longitudinal nature of the model and the general longitudinal theory of student retention. They also established that the effects of academic and social integration were time-dependent and had their most dramatic impact in the time periods immediately after being received. Results further indicated that the effects of early measures of academic performance and social integration were important indicators of long-term persistence. Additional findings suggest need for further examination of the effects of the required pre-freshman summer program on persistence. Contains 47 references. (MSE)

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ED 397 732

IMPLEMENTING ASTIN'S I-E-O MODEL IN THE STUDY OF STUDENT RETENTION: A MULTIVARIATE TIME DEPENDENT APPROACH

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May 1996

AE 029 332

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for Management Research, Policy Analysis, and Planning

This paper was presented at the Thirty-Sixth Annual Forum of the Association for Institutional Research held in Albuquerque, New Mexico, May 5-8, 1996. This paper was reviewed by the AIR Forum Publications Committee and was judged to be of high quality and of interest to others concerned with the research of higher education. It has therefore been selected to be included in the ERIC Collection of Forum Papers.

Jean Endo
Editor
AIR Forum Publications

ABSTRACT

Astin's Input-Environment-Outcomes model was utilized to study persistence at the United States Coast Guard Academy. Because the study was conducted in a controlled social environment, measures of social environmental influence were derived from multiple inputs including adaptability polls wherein every student's "fit" was assessed by all others in his/her company (organizational unit) each semester.

A longitudinal ex post facto research design was employed. In addition to using dichotomous variables to investigate persistence during each semester, the number of days enrolled was utilized as a continuous measure of persistence.

Multivariate statistical techniques, including canonical correlation, demonstrated that input variables were not statistically important indicators of persistence. However, they were related to measures of academic and social integration, which, in turn, were potent, time dependent, indicators of persistence--confirming the general longitudinal theory of retention.

INTRODUCTION

While many of the studies of student retention reported in the literature have found that persistence involves a process of academic and social integration between the student and the institution, many of them have arrived at this conclusion by analyzing individual factors, mostly student characteristics and self-reported measures, one at a time and in isolation. By relying primarily on univariate comparisons, many studies have employed techniques that compared only average overall differences in a number of distinct dimensions. The danger in this approach is that a truly multidimensional phenomenon is reduced to a number of one dimensional comparisons.

Even in instances in which multivariate statistical techniques were employed, many studies have investigated the relationship between a single dependent variable and those input factors related to it without regard for the reality that an individual's social and academic integration is a dependent multidimensional vector. To analyze single dimensions of this vector in isolation from other dimensions ignores their interaction and the multi-faceted nature of environmental influences. Moreover, few studies reported in the literature have analyzed the effects of social and academic integration in a time-dependent sense.

PURPOSE

The primary aim of this study was to investigate the process of retention in the context of the longitudinal Input-Environment-Outcome model proposed by Astin (1993). The I-E-O model captures the longitudinal nature of the process, highlights the interactivity between student background characteristics and the college environment, and provides a broad context in which institution-specific investigations of attrition can be conducted.

The study focused on three primary areas: (1) The relationship between input variables and persistence outcomes, (2) The relationship between measures of academic and social involvement and persistence outcomes, and (3) The relationship between input variables and measures of academic and social involvement. To investigate the process in a sequential manner and account for the effects of time, the relationships among the elements of the I-E-O model; namely, input variables, measures of academic and social involvement, and persistence outcomes, were investigated over a four-year period of matriculation.

LITERATURE REVIEW

Most of the input variables utilized in investigations of attrition lack consistency across studies. Of course, some generalizations are possible. Broadly speaking, persisters have better high school academic records (Astin, 1971; Dey, 1990; Lenning, 1982; Pantages and Creedon, 1978; Ramist, 1981; Summerskill, 1962), have more ambitious educational goals (Astin, 1975;

Bridges, 1975; Cope and Hannah, 1975; Elkins and Luetkemeyer, 1974; General Accounting Office, 1976; Grosset, 1989; Johnson and Richardson, 1986; Lenning, Beal, and Sauer, 1980; Priest, 1986; Ramist, 1981), and have higher standardized aptitude test scores than dropouts (Astin, 1993; Dey, 1990; Ramist, 1981). In general, persisters have more educated parents (Astin, 1975; Hayden and Holloway, 1985) and are more likely to be of traditional college age than dropouts (Astin, 1975; Dann and Abrahams, 1970; Grosset, 1989). Despite this general profile, many persons with such characteristics withdraw from college. In fact, when considered individually, none of the input variables generally correlated with dropout behavior consistently predict attrition across studies. Even when combinations of input variables are utilized to predict attrition, the results are frequently inconsistent from study to study and no universal persisting-type emerges from the literature dealing with individual background characteristics.

By demonstrating that Durkheim's (1951) theory of egoistic suicide extends to the process of dropping out of college, both Spady (1970, 1971) and Rootman (1970) established that attrition, like egoistic suicide, may result when an individual fails to become socially or intellectually integrated into the college community. Building upon the systems explanation of the attrition process provided by Spady and Rootman, Tinto (1975) argued that individuals withdraw from a college when they believe the cost of their investment of time, energy, and resources outweighs the benefits accrued by remaining in that college. Because such a cost-benefit analysis is inescapably tied to the particular institution at which an individual is enrolled, Tinto concluded that it is the interplay between the individual's integration into the academic and social systems of the college, as it modifies one's commitment to the goal of college completion and commitment to the institution, that determines whether or not the individual decides to drop out. Consequently, Tinto theorized that a predictive model of attrition must account for the unique interactions generated by a particular individual-institution combination. In doing so, he emphasized the need for institution-specific analyses of the attrition process and laid the foundation for the development of individual retention programs throughout many institutions of higher education.

This interactive view of the retention process has been validated by a number of studies. Lenning, Beal, and Sauer (1980, p. 43) summarized their review of the literature on retention by noting that "while it is true that researchers and theorists have viewed retention from various perspectives, a common conclusion has been that retention and attrition result from the interactions between persons and institutions. . . . The characteristics of the interaction, not the student or institution alone, affect a student's decision to stay or drop out." Cope and Hannah (1975, p. 77) noted that satisfaction "depends not only on the college and its program, but also on the tastes and tolerances students bring at entrance." For example, Lenning (1982) found that when students show extreme orientation to independence and autonomy, a conformist college

and classroom atmosphere will tend to result in withdrawal; if the college environment does not support creativity, extremely creative people will tend to withdraw; and although, in general, assertiveness tends to be related to persistence, where it is ridiculed because others at the college see the assertive person as rude, assertive students tend to withdraw. He concluded that a sense of incongruence arising from dissatisfying student interactions contributes to attrition to the extent that it is not moderated by other factors or ameliorated by a willingness to endure dissatisfaction. Lenning (1982, p. 40) concluded that "the degree of congruence or discrepancy between what the student expects from college and the reality of the college environment may be a major factor in persistence/withdrawal behavior."

The General Accounting Office (1976a, p. 62) concluded that "the only way to understand the phenomenon of dropping out was to view it in the context of a lack of fit between the needs, desires, values, aspirations, and abilitities of the student on the one hand and the perceived opportunities in the college environment to express or satisfy those characteristics on the other." Astin (1975) noted that students' chances of persistence are improved if their backgrounds are similar to those of other students. In particular, he found that black students drop out more frequently when they attend predominantly white institutions; students from rural and farm backgrounds seem to drop out more frequently if they enter large universities; and Jewish or students with no religious preference are more likely to leave traditionally sectarian institutions. Although similarities of race, religion, or type of hometown may contribute to the "fit" that a particular student feels within a certain college environment, the notion of "fitting in" has been found to go beyond simple demographic characteristics.

Rather, the notion of student-institution fit seems to encompass all of the dynamics associated with incorporation into the extremely complex human community of the college. Because the process of "fitting in" is dynamic and interactive, to model its effect on attrition requires measures capable of capturing the interconnectivity of students and the college environment. Although analyzing individual characteristics alone and investigating the particular effects of institutional variables frequently provides meaningful insights into the attrition process, measures of performance, measures of adaptability and assimilation, and measures of satisfaction must be considered to understand more fully the kinetics of the withdrawal process. Indeed, the major conclusion to be drawn from the literature is that withdrawal may be viewed most effectively as a "transaction" between the individual and the college (Astin, 1975). If this is the case, it follows that variables which account for this transaction may be important indicators of the attrition process.

Many studies have validated the general premise of the longitudinal interactive process postulated by Tinto and Spady. This is especially true regarding the role of background characteristics. In contrast to early descriptive studies which searched almost exclusively for

direct links between prematriculation or selection variables and attrition, the longitudinal models of attrition suggest that an interactive process between the student and the institution mediates the effects of background characteristics. Terenzini and Pascarella (1980, p. 280), in a review of six studies they conducted to validate Tinto's model during the period 1977 to 1980, found that in none of them could "reliable predictions of attrition status be made solely on the basis of pre-college traits." However, they also concluded that while precollege characteristics may not be directly related to attrition, such characteristics are certainly related to measures of academic and social integration, which, in turn, made statistically significant contributions to explain the variance associated with persistence in their studies.

Background characteristics, Terinzini and Pascarella (1980, p. 280) concluded, are important but only to the extent that they help determine academic and social integration through an interactive process with the college environment. That is to say, determinants of persistence are not solely embodied in the kinds of students enrolled, but "are subject to the influence of institutional policies, programs, or conditions that affect students after their arrival on campus." After an extensive review of the literature, Pascarella (1980, p. 50) reported that although there is considerable evidence to suggest that aptitude and prior achievement are primary determinants of college achievement, "it would appear that certain aspects of the institutional environment, and in particular the predominant attitudes and values of different student peer cultures, may modify the relationship between aptitude and college achievement by positively or negatively influencing the importance which a student attaches to the level of his or her academic performance."

By verifying that background characteristics affect attrition through an interactive process with the college environment, researchers have confirmed the notion that institutions are indeed active participants in the determination of withdrawal behavior. Indeed, utilizing factors such as involvement in extracurricular activities (Astin, 1975; Beil and Shope, 1990; Lenning, 1982; Sexton, 1965; The Women Midshipmen Study Group, 1987), peer associations (Astin, 1993; Bean, 1985; General Accounting Office, 1976a; Rootman, 1970), faculty contacts (Pascarella, 1980; Pascarell and Chapman, 1983), participation in the academic life of the institution (Tinto, 1987), academic performance criteria (Astin, 1971, 1975; Beil and Shope, 1990; Brendel, 1985; Bridges, 1975; Edwards and Waters, 1983; Lenning, 1982; Levin and Wyckoff, 1990), and other factors reflective of the degree to which students fit into both the academic and social systems of the college, a number of researchers have validated the relationship between measures of academic and social integration and persistence.

There are, of course, inconsistencies found in the empirical results of many studies. For example, although numerous studies confirmed the validity of many parts of Tinto's original model, few, if any, confirmed all of the causal relations among the various constructs of his model. The findings associated with the roles of academic and social integration and their

connection with initial and subsequent measures of goal and institutional commitment are particularly inconsistent. For example, Pascarella and Terenzini (1983) found that academic integration directly influenced goal commitment while social integration was a significant and direct determinant of institutional commitment; and, as postulated by Tinto, they found both measures of commitment to be linked to persistence. However, they also found, contrary to Tinto's model, that both academic and social integration had approximately equal and direct effects on persistence. Pascarella, Duby, and Iverson (1983) also found direct relationships between both academic and social integration and persistence but found no reliable paths between either form of integration and goal or institutional commitment. Similarly, Stage (1988) found that academic and social integration were both directly related to persistence, but there was no direct link between academic integration and either goal or institutional commitment. She found social integration to be a direct determinant of institutional commitment which was, in turn, significantly related to persistence, but she also reported that goal commitment was not directly related to persistence. This result supported the findings of Terenzini, Pascarella, Theophilides, and Lorang (1985) who found institutional commitment was more powerfully related to persistence than goal commitment and the findings of Pascarella and Terenzini (1983) who found that "the effect of institutional commitment was nearly three times that of goal commitment."

Although he used a slightly different conceptual model of attrition, Bean (1980) found that, based on total causal effects, institutional commitment was the most powerful indicator of dropout behavior. In fact, for men it was twice as important as the next most highly correlated variable, while for women, it was over four times as significant as the second most important factor. In a later study to examine the role of socialization and the effects of socializing agents in the attrition process, Bean (1985, p. 2) reported that "the student who already values intelligence, and membership at a particular institution, will be more likely to fit in at the institution, succeed there as a student, and remain enrolled until graduation." In that study Bean found that fitting in (working through a measure of one's intent to leave) and achieved grade point average at the end of the freshman year were the two most important predictors of first-year attrition. Contrary to Tinto's original model, substantial evidence exists to suggest that academic integration, social integration, and institutional commitment are all important, direct, determinants of attrition. There are, however, some inconsistencies.

Terenzini et al. (1985), in an attempt to validate an earlier study in which direct paths were found from both academic and social integration to persistence, found no direct link between academic integration and persistence and, in a most perplexing finding, discovered that social integration had a direct, but negative, relationship with persistence. They also failed to find a direct link between social integration and subsequent insititutional commitment but did find

academic integration positively and significantly related to both goal and institutional commitment. Munro (1981) found that academic integration had a strong effect on persistence but social integration had no significant effect. Contrary to Tinto's model and the findings of other researchers, she found that academic integration, not social integration, had the strongest effect on institutional commitment, and institutional commitment was not directly related to persistence.

In a study to examine the effects of an academic orientation program on the persistence of first-year students, Pascarella, Terenzini, and Wolfle (1986) found that social integration, goal commitment, and institutional commitment all had significant direct effects on persistence. They also found that academic orientation had significant indirect effects on persistence by influencing both social integration and subsequent commitment to the institution. In contrast to these findings, Braxton, Duster, and Pascarella (1988), in a study to investigate the effects of academic advising on freshman persistence, found that academic integration had a significant direct, positive effect on institutional commitment, which, in turn, was directly related to persistence. Moreover, social integration was not directly related to institutional commitment nor was there a direct path from academic integration to goal commitment.

Obviously, all studies investigating the attrition process have not arrived at precisely the same conclusions. This seems especially true regarding findings associated with the role of social integration. Differences found regarding this dimension are most likely the result of difficulties in defining the concept. Widely different techniques and methods of assessment have been used to define social integration. Without fail, in every study reviewed, social integration was defined through the use of some type of self-reported questionnaire or survey. Not only is there a lack of standardization of the concept, it has, in essence, been defined only from the student's perspective. Social integration, it seems, has never been considered from the standpoint of institutional expectations.

Indeed, differences in defining and variations in measuring each of the constructs associated with any of the longitudinal models contribute to disparities which make results across studies difficult to compare. The degree to which the constructs included in the analyses differ--that is, differences in specification--also affects the extent to which meaningful comparisons can be made. Similarly, any peculiarities associated with the institution or sample under investigation may make it inappropriate to compare results from one study with findings from another. Although a number of common themes have emerged, given the extent to which methodologies, samples, and the variables utilized differ among studies of student attrition, it is hardly surprising that results are often inconsistent. Nonetheless, ample support exists to conclude that attrition can be modeled as a longitudinal process in keeping with the models proposed by Spady, Rootman, Tinto, Bean, and others. Also, it is clear that the attrition process

is most strongly influenced by the interactional activities which take place within the institution following entry (Tinto, 1987).

In this regard, retention can be viewed as an outcome of the process of higher education and can be analyzed, in general terms, using Astin's Input-Environment-Outcome (I-E-O) model. According to Astin (1993, p. 7), "inputs refer to the characteristics of the student at the time of entry to the institution; environment refers to the various programs, policies, faculty, peers, and educational experiences to which the student is exposed; and outcomes refers to the student's characteristics after exposure to the environment." Although this model is a simpler conceptualization of the attrition process than depicted in the longitudinal models proposed by Spady and Tinto, it captures the interactional essence of the process in a straightforward and meaningful manner.

In studies of student attrition using the I-E-O context, the environmental factor, in keeping with the longitudinal view, is dominated by measures of student involvement. Of particular importance are measures of academic involvement, involvement with student peers, and involvement in other formal and informal activities associated with the college experience. Accordingly, to model the attrition process using the I-E-O model the crucial requirement is the identification of relevant input characteristics and appropriate measures of involvement.

DATA SOURCES

The Sample

The sample was derived by combining all 338 cadets entering the Coast Guard Academy for the first time with the class of 1991 and all 288 cadets entering the Academy for the first time with the class of 1993. However, before proceeding with any analyses, seven subjects were eliminated due to their unique status as foreign students attending the Coast Guard Academy as part of a special arrangement made through the State Department of the United States.

Prior to combining the entrants to the classes of '91 and '93, statistical comparisons were conducted which revealed that these two groups had similar profiles with regard to the input variables utilized in the study. Similarly, no significant changes in the curriculum or the military training requirements in place at the Academy occurred to differentiate the experiences of these two classes while they were enrolled. Thus, based on the input variables utilized in this study and the similarity in the general environmental influences operating while they attended the Academy, the classes of '91 and '93 were statistically similar. Combining them into one group for the purpose of the present study provided a sample of sufficient size to carry out multivariate statistical analyses. Thus, the sample ultimately consisted of 619 subjects.

Because of age restrictions imposed on entrants to the Coast Guard Academy, nearly the entire sample consisted of first time college students; only about 10 percent reported any prior

college experience. Most of the entrants were eighteen years old, and more than 96 percent of the subjects were less than nineteen years of age. The average mathematics Scholastic Aptitude Test score of the sample was 622, and the average verbal Scholastic Aptitude Test score was 531. Nearly 90 percent of the sample graduated in the top 20 percent of their high school class. The sample was predominantly white and male. Minorities comprised less than 9 percent of the sample, and less than 15 percent of the subjects were women.

Measures and Outcome Variables

Input Variables. The degree to which the I-E-O model can effectively portray the process of persistence at a particular institution is dependent upon the extent to which the input variables and measures of interaction and involvement utilized are relevant factors in the process. Thus, the selection of input variables and environmental or involvement measures should be based upon their perceived applicability in the particular situation under study.

Academic potential as evidenced by scores on standardized college entrance examinations has been found to be one of the most potent indicators of academic achievement and persistence in college. Because the Coast Guard Academy utilizes both SAT and ACT scores in its selection process, the scores upon which an individual was granted admission were used as measures of scholastic aptitude. From among the sets of college entrance examination scores submitted by each subject, the highest scores achieved in the mathematics and verbal/English sub-sections of the SAT or ACT examination were utilized. However, to analyze these measures on a common metric, ACT scores were converted to comparable SAT scores using a table of concordance specifically developed for use at the Coast Guard Academy (Kelly, 1991). Both mathematical (MSAT) and verbal (VSAT) scores were utilized.

As a measure of prior academic achievement and background, high school rank (HSR), one of the strongest single variable predictors of persistence available, was included in the present study. High school ranks were recorded as raw scores as noted on the official high school transcript. Thus, in interpreting analyses of high school rank, a lower score corresponds to a better rank in the individual's high school graduating class.

Although the findings are inconsistent, there is some evidence that graduates of small high schools are more likely to drop out of college. Likewise, some studies have found that school size may also be related to attrition both in opportunities provided for social development and in the "Goldilocks" phenomenon that "rightness" of size of the college may reflect prior experience with size. Thus, high school size (SIZE) may be an important variable related to the persistence of cadets and was included as an input variable in the present study.

Although hometown location has not been a consistently significant indicator of persistence, some studies have found a significant correlation between dropping out and the

distance between the student's hometown and the college. Given the limited opportunities that cadets have for leave and liberty, distance from home may be a proxy for opportunity to maintain contact with high school friends, which may detract from the development of close friendships within the Corps of Cadets. Because a tremendous premium is placed on the establishment of esprit de corps at the Coast Guard Academy, those cadets who maintain close friendships exclusive of those within the cadet system might be viewed as less integrated into the social system of the Academy. In light of the well documented connection between social integration and attrition from college and the emphasis placed on teamwork and allegiance to one's platoon or class, distance (DIST) from home may have special significance regarding attrition at the Coast Guard Academy. Using official government mileage charts, the distance from each subject's home of record upon entry to the Coast Guard Academy was recorded to the nearest mile.

Although not generally considered in studies of attrition at typical four-year colleges, because of the unique physical demands placed on cadets, physical fitness may also be related to persistence at the Coast Guard Academy. The initial physical fitness examination (SUMPFE) is administered to new cadets during the summer of their arrival at the Academy. The SUMPFE consists of pull-ups (for men) or flexed arm hang (for women), sit-ups in two minutes, standing long jump, 300 yard shuttle run, and a two mile run. According to Cardinali (1978), the items contained in this test are recommended as standards by the International Committee on Physical Performance Tests and are designed to determine the capability of a cadet to endure the vigorous and strenuous activity that is demanded at the Academy.

As part of the admissions process at each of the federal service academies, an extensive review of each candidate's participation in high school athletic, nonathletic, and leadership activities is conducted. At the Coast Guard Academy each candidate is required to submit a standardized form, validated by a high school official, reporting his or her involvement in high school activities and leadership positions. This form is reviewed by a panel of three members of the Cadet Candidate Evaluation Board (CCEB) and scored by each member independently. These individual scores are averaged and comprise 40 percent of the candidate selection score. The other 60 percent of the selection score is computed based on a composite of high school rank, VSAT, and MSAT scores.

Because, as reported by Ramist (1981), studies have shown that "women are more likely to drop out when the ratio of men to women is high," GENDER was a 0-1 binary input variable in the current study. Because of the small number of minorities enrolled at the Coast Guard Academy, RACE was also considered as a dichotomous input variable in light of Tinto's (1987) finding that "the persistence of minority students often hinges upon there being a sufficiently large number of similar types of students on campus with whom to form a visible community."

Measures of Involvement. College grade point average (GPA), a usual measure of academic integration, was used in this study. However, because of the tightly controlled environment associated with its role as a military college, social integration at the United States Coast Guard Academy was defined in a much more robust fashion than the usual self-reported measures typically found in the literature.

In contrast to students at other institutions of higher learning, a Coast Guard Academy cadet's degree of social integration may be reflected through compliance with clearly delineated expectations and mores. From an institutional standpoint, the extent of a cadet's integration is measured in several ways. Adaptive skills ratings (ADAPS), which represent how the cadet is perceived as a member of the team regarding communicating, listening, and working effectively with or for others are generated each semester. Using these basic tenets as a guideline, each cadet is ranked by every classmate in his or her company. Then, using a formula which forces the distribution of adaptability for service scores to coincide with a two hundred point interval scale, a within-class adaptability for service score is computed for each cadet. These ratings provide an assessment of how cadets are perceived by their peers regarding their "fit" within the highly structured social environment of the Academy.

Conduct evaluations (CON) are also completed each semester and provide another potential indication of how well an individual has adapted to the dominant social system. Conduct scores are derived by dividing the number of demerits received for conduct violations during a particular term by the maximum number of demerits allowed for the term. This quotient is then converted to a two hundred point interval scale. An individual receiving no demerits receives a conduct score of two hundred points while someone receiving the maximum allowable demerits earns a conduct score of zero--an extremely rare event.

Additionally, a commissioned officer is assigned to each company of cadets to evaluate the overall contribution of individual cadets to the Academy through involvement in the general Academy environment (athletics, clubs, activities, etc.). According to the Regulations for the Corps of Cadets, "high evaluation in these performance dimensions will normally result from cadets subscribing to and vigorously participating in the nonacademic program at the Academy." Company officer evaluations (COE) are reported on a three hundred point scale and represent a measure of a cadet's participation in extracurricular activities. As such, they also represent an assessment of the degree to which an individual cadet is integrated into the social community of the Academy.

There is undoubtedly a complex process of interactions which ultimately define an individual's integration into the social fabric of any organization. However, in the context of the structured Academy environment, a multidimensional combination of adaptive skills ratings, conduct ratings, and company officer evaluations comprise an institutionally defined measure of

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social integration at the Coast Guard Academy. Each of these was utilized as a measure of involvement in the current study.

Outcome Variables. To determine the effects of the input variables and measures of involvement on persistence to on-time graduation, the dichotomous variable ONTIME was utilized and coded as follows:

ONTIME = 0 if the subject did not graduate on the regular graduation date
1 if the subject graduated on-time

While the dichotomous variable ONTIME provides a classification of on-time graduates and dropouts , it does not distinguish subjects in a manner that permits a time-dependent assessment of persistence. To study the effects of the input variables and measures of involvement on persistence over time, the normal four year period of matriculation was divided into eight distinct intervals: initial summer, freshman fall, freshman spring, freshman summer, sophomore fall, sophomore spring, sophomore summer, and the junior and senior years combined. Separate 0-1 indicator variables were defined for these intervals in the same manner as the ONTIME variable.

Using each of these binary dependent variables as persistence criteria facilitated an examination of the manner and extent to which the input variables and measures of involvement were related to persistence over time. However, while these dichotomous variables provided a useful mechanism for investigating the effects of the input variables and involvement measures on persistence at successive points in time, to move beyond comparing dropouts and persisters *at* specific points in time and to investigate the strength of the influence that each of the input and involvement variables exerts on attrition *during* each of the time periods analyzed in the study, a continuous measure of persistence was desirable. Accordingly, the number of days that each subject was enrolled (DAYS) was computed and utilized as a continuous outcome measure. Using days enrolled allowed the effects of the input and involvement measures to be measured continuously over time and extended the longitudinal perspective of the study.

METHODOLOGY

By sequentially investigating the relationships among the input variables, the involvement measures, and the persistence outcomes using univariate and multivariate statistical techniques, the longitudinal connections among the variables were analyzed. Moreover, by analyzing the effects of each of the input variables and involvement measures on persistence over time, singularly and in the presence of each other, the design permitted an assessment of the impact of each variable in a time-dependent manner.

The research questions addressed and the statistical techniques used to investigate each of them are given in the table below. Particular emphasis was placed on multivariate techniques. Of special interest was the use of canonical correlation, a multivariate technique employed in no other studies reviewed in the literature.

Research Question	Statistical Procedures
1. Based on the input variables alone, to what extent and in what manner can those who withdraw be differentiated from those who persist over time?	1. T-tests and chi-square tests to compare groups. 2. Product moment correlations to assess strength of univariate relationships. 3. Multiple regression analyses to assess multivariate effects of inputs. 4. Discriminant function analyses to assess the adequacy of classification.
2. Based on measures of academic and social involvement reported at the end of each of the first four semesters, to what extent and in what manner can those who withdraw be differentiated from those who persist over time?	1. T-tests and chi-square tests to compare groups. 2. Product moment correlations to assess strength of univariate relationships. 3. Multiple regression analyses to assess multivariate effects of involvement measures. 4. Discriminant function analyses to assess the adequacy of classification.
3. To what extent and in what manner are the input variables related to the measures of academic and social integration reported at the end of each of the first four semesters?	1. Product moment correlations to assess strength of univariate relationships. 2. Multiple regression analyses to assess multivariate effects of inputs. 3. Canonical correlational analyses to assess the multivariate relationships.

FINDINGS

Input Variables and Persistence: Research Question #1

The findings associated with the relationship between the input variables and measures of persistence utilized in this study confirmed that, in a statistical sense, input variables have little, if any, meaningful direct impact on student persistence. Univariate statistical tests on each of the input variables found statistically significant differences between on-time graduates and those not graduating on time with regards to MSAT and CCEB scores only. In general, on-time graduates had higher MSAT scores than those who left the Academy. Conversely, on-time graduates, as a group, had lower CCEB scores than those who withdrew.

Separate correlational analyses associated with the initial summer, freshman year, sophomore year, and the junior and senior years combined, demonstrated that higher MSAT scores and lower CCEB scores were reliably correlated with persistence during the sophomore year only, and CCEB scores alone were significantly related to persistence during the junior and senior years. Individually, no other input variable was a reliable indicator of persistence during

any of the periods analyzed. Additionally, when analyzed in a multivariate context using multiple linear regression, none of the input variables emerged as a significant indicator of persistence; and no reliable regression functions linked persistence during any of the periods analyzed to the set of input variables.

Conducting analyses of the relationship between the input variables and persistence at several points in time did, however, reveal some key differences between persisters and dropouts. Although not generally statistically significant, a consistent profile of persisters during the freshman, sophomore, and junior and senior years combined emerged with regards to the individual input variables. During each of these time periods, men were more likely to persist than women; and persisters had, on average, higher scholastic aptitude test scores, better high school rankings, and slightly higher summer physical fitness examination scores than those who withdrew from the Academy. Additionally, as a group, persisters graduated from larger high school classes and lived closer to the Academy upon entry than those who dropped out.

Interestingly, a multiple regression of CCEB scores on the other input variables revealed that they were significantly related to lower VSAT and MSAT scores, lower SUMPFE scores, poorer high school rankings, graduating from a smaller high school class, being non-white, and being a woman--all factors mitigating against persistence during the freshman, sophomore, and junior and senior years combined. While CCEB scores are purported to evaluate extracurricular achievement in high school, based on the present analysis, they seemingly also significantly compensate for poorer aptitude test scores and poorer high school rankings and increase the admissions scores of non-white and female cadets. While students in the sample were deemed fully qualified for admission to the Coast Guard Academy, the evidence suggests that the extent to which Cadet Candidate Evaluation Board scores helped them gain admission was indicative of the likelihood of their withdrawal from the Academy once the freshman fall semester began. In fact, analysis confirmed that the ratio of the Cadet Candidate Evaluation Board score to the total admissions score was significantly and negatively correlated with on-time graduation.

Linking the relationships among the input variables and the number of days that dropouts were enrolled (DAYS) with the results associated with the analyses of the various binary persistence criteria not only established which inputs were important in distinguishing persisters from dropouts, but also allowed the manner in which they exerted their influence over time to be assessed. For example, a multiple linear regression of the number of days that dropouts from the Academy were enrolled (DAYS) on the entire set of input variables revealed that gender was highly correlated with DAYS ($p = .0192$). This finding implied that women who left the Academy tended to do so much later than men. Likewise, with a p-value of .0251, CCEB scores were positively correlated with DAYS. This indicated that dropouts with higher CCEB scores tended to remain enrolled longer than those with lower CCEB scores.

Although much useful information, particularly from the standpoint of student selection and admission, was derived from the investigation of the relationships among the input variables and the outcome measures utilized in this study, the analyses of the input variables suggested they were not, either separately or in combination, especially powerful direct indicators of student persistence. Despite several instances in which input variables achieved statistically significant associations with persistence, the input variables explained very little of the variance in the persistence criteria. In fact, in the very best case, a multiple regression of the ONTIME graduation criterion on the entire set of input variables produced a multiple coefficient of determination of only .053.

Involvement Measures and Persistence: Research Question #2

As postulated in Astin's I-E-O model and in the general longitudinal theory of student retention, the measures of involvement utilized in the study were significantly related to persistence. Multiple regression analyses verified a statistically significant relationship, well beyond the .01 level, between the set of involvement measures reported at the end of each of the first four semesters and the ONTIME persistence criterion.

Based on its beta weight and associated test of significance, term grade point average (TGPA), in the presence of the other involvement measures, consistently emerged as the most powerful indicator of persistence to on-time graduation. For every semester analyzed, term grade point average was positively and significantly related to the ONTIME criterion. In fact, it was the only involvement measure significantly related to on-time graduation at the .01 level in each of the regression functions derived.

Although a tremendous amount of variability in the subjects remained, the data suggest that by the end of the spring sophomore semester persisters and eventual dropouts were more easily distinguished from one another on the basis of measures of involvement. Based on the discriminant function classifications derived, dropouts, in particular, were identified more easily over time. That is, while the variability of the involvement measures remained fairly constant among on-time graduates, the dropouts became more homogeneous and more easily identified by their involvement measures profile.

By the end of the spring sophomore semester, the sixty-five students who subsequently left the Academy were so similar that 77 percent of them were identified correctly on the basis of their measures of involvement. Over time, dropouts were characterized primarily by increasingly low term grade point averages and low adaptability for service scores. Accordingly, those characteristics emerged as the primary factors which distinguished persisters and dropouts after the spring sophomore semester. However, while dropouts during the junior and senior years were most clearly distinguished from persisters on the basis of measures of involvement

associated with the fall and spring sophomore semesters, they also were distinguished by lower term grade point averages, lower company officer evaluations, and lower conduct ratings during the freshman year--a finding revealed only through the analysis of the relationship between measures of involvement and persistence over time.

Analysis of the measures of involvement over time also revealed that they were most highly related to persistence in the time period immediately subsequent to being received. For example, multiple regression analyses demonstrated that the fall freshman measures of involvement were significantly related to persistence, well beyond the .01 level of significance, during the freshman spring and summer, but they had no statistically meaningful association with persistence during the sophomore year. Likewise, involvement measures reported at the end of the spring freshman semester were significantly related to persistence during the freshman summer and sophomore fall ($p = .0012$), but they were not significantly associated with persistence during the sophomore spring or summer. Involvement measures reported at the end of the fall sophomore year were significantly related to persistence in the sophomore spring and summer. They were also significantly related to persistence during the junior and senior years, but to a lesser extent than that found in the sophomore spring and summer.

Input Variables and Academic and Social Involvement: Research Question #3

While the input variables were not, in general, statistically important direct indicators of persistence, they were directly and significantly related to the measures of academic and social involvement utilized in this study. Except for conduct ratings, multiple regression analyses confirmed statistically significant relationships during each of the first four semesters between the input variables and each of the measures of involvement utilized in the study.

Initial summer physical fitness examination scores were the most consistent and potent indicators of adaptability for service scores and company officer evaluations. Having a higher MSAT score, reporting a better high school class rank, and graduating from a larger high school class, in that order, were the most powerful indicators of term grade point average during each of the first four semesters. Based on the regression analyses, no consistently reliable correlates of conduct ratings were found among the input variables.

By examining the relationship between the set of input variables and the set of measures of academic and social integration from a multivariate perspective, canonical correlation analyses also confirmed that the input variables were significantly related to the measures of involvement. This direct link confirmed the longitudinal connection between input variables and measures of academic and social integration proposed by Spady, Tinto, Bean, Astin, and others.

A canonical correlation analysis of the relationship between the input variables and the measures of involvement reported at the end of the semester produced two significant canonical

variate pairs for each of the four semesters analyzed. The first and most powerfully connected involvement variate was dominated by the term grade point average variable. In fact, except for the fall freshman semester, term grade point average emerged as the only involvement variable correlated above 0.3 with the first involvement variate. Scholastic aptitude test scores (MSAT and VSAT) and Cadet Candidate Evaluation Board (CCEB) scores were consistently correlated above 0.3 with the first input variate. RACE was also heavily loaded on the first input variate during the spring freshman semester and each of the sophomore semesters. However, due to the limited number of non-white students in the sample, the results associated with RACE were subject to some instability and viewed with caution.

As a pair, the first canonical variates derived in each semester were significantly correlated well beyond the .01 level of significance and strongly reflected a connection between the input variables and term grade point average for each semester analyzed. Thus, the first canonical variate pair was primarily indicative of the manner in which the input variables affected academic integration. In a multivariate sense, the first canonical variate pair derived for each semester indicated that students with high aptitude test scores, especially in mathematics, and low Cadet Candidate Evaluation Board scores were most likely to attain high grade point averages.

Adaptability for service was the only involvement measure consistently related to the second canonical involvement variate. In general, however, the second involvement variate consisted of a combination of adaptability for service scores, company officer evaluations, and conduct ratings--all measures of social integration and involvement. The second input variate was most strongly influenced by summer physical fitness examination scores and, to a lesser extent, gender and race, in that order.

Although not as significant as the first canonical variate pair, the second variates derived for each semester analyzed were also correlated well beyond the .01 level of statistical significance and reflected the manner in which the input variables influenced the measures of social involvement employed in the study. Although the nature of the second canonical variate pair was consistently reflective of social integration, the specific manner in which the input variate correlated with the involvement variate was not consistent for all of the semesters analyzed.

For example, the second canonical variate pair derived for the fall sophomore semester indicated that white male cadets with high summer physical fitness examination scores tended to receive high adaptability for service scores and low conduct ratings. However, the analysis of the spring sophomore semester indicated that students with this same profile received high adaptability for service scores and high company officer evaluation scores.

A related, but slightly different, interpretation was associated with the second canonical variate pair derived from the data associated with the spring freshman semester. In that semester, the loadings indicated that women with low summer physical fitness examination scores tended to receive low adaptability for service scores, low company officer evaluations, and high conduct ratings. In the fall freshman term gender was not significantly loaded on the second input variable. A relationship between summer physical fitness scores and adaptability for service scores did, as noted in every other semester, emerge in the fall freshman semester also. During that semester, students with high summer physical fitness scores and high verbal aptitude test scores, regardless of gender, tended to receive high adaptability for service scores, high company officer evaluations, and high term grade point averages.

While none of the findings associated with the second canonical variate pair were contradictory, they lacked the consistency associated with the interpretation of the first canonical variate pair. Despite slight variations, the second canonical variate pair was consistently reflective of the manner in which the input variables affected measures of social involvement. The first canonical variate pair was, except for the fall freshman term, exclusively indicative of the relationship between the input variables and academic achievement.

Thus, the canonical correlation analyses confirmed the existence of both an academic and a social dimension of involvement. While statistically significant canonical variate pairs reflected the influence of the input variables on both of these dimensions, the connections associated with the academic dimension were demonstrably stronger and more consistent than those associated with the social dimension.

CONCLUSIONS

By establishing the sequential connection between inputs, involvement measures, and persistence outcomes, the study confirmed the longitudinal nature of Astin's I-E-O model and the general longitudinal theory of student retention. The findings also established that the effects of academic and social integration, as measured by the involvement measures utilized in this study, were time dependent and had their most dramatic impact in the time periods immediately after being received. The results further indicated that the effects of early measures of academic performance and social integration were also important indicators of long-term persistence.

Canonical correlation analysis confirmed that input variables were connected to two dimensions of involvement, one almost exclusively academic and the other social. The correlates of academic integration were dominated by aptitude test scores, especially the MSAT, and Cadet Candidate Evaluation Board scores. The social canonical variate pair was most strongly influenced by scores on the summer physical fitness examination, gender, and race. Multiple regression and discriminant function analyses confirmed that persistence was affected

by a combination of the academic and social measures utilized in the study, but persistence was most strongly and directly influenced by term grade point averages, and persisters were best distinguished from dropouts on the basis of academic performance.

The manner in which the input variables correlated with persistence during the initial summer, a period of military indoctrination similar to that employed at the other service academies but not relevant to other colleges and universities, was essentially the opposite of that associated with persistence once the fall semester began. This implied that the factors linked to long-term persistence are nearly the same as those associated with withdrawal during the initial summer. Given the tremendous loss of students at the Coast Guard Academy during the initial summer and the fact that many who departed during that time possessed backgrounds that predicted persistence subsequent to the initial summer, a more extensive review of the connection between the initial summer and the rest of the four year program at the Academy should be undertaken. The finding that Cadet Candidate Evaluation Board scores were potent indicators of low term grade point averages and ultimate withdrawal also deserves more extensive analysis.

Because the measures of academic and social integration used in this study were based on multiple inputs, these measures would seem to be more reliable than the self-reported measures found in other studies reviewed. In testing the longitudinal model of student retention, this was considered to be a major advantage. However, other than at the other service academies, it is doubtful that many colleges are able to require such externally generated measures.

The research design utilized in this study enabled an investigation of the effects of the input variables and the measures of involvement over time. Furthermore, the multivariate statistical techniques employed accounted for the interconnectivity of the inputs and measures of involvement in the analyses and revealed the time dependent effects that the measures of academic and social integration had on persistence. The methodology employed in this study is certainly applicable to any institution and is recommended in those situations where a view of the retention process over time is desired.

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